

REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have added new claim 27 to the application, as the sole independent claim therein. Claim 27 recites a polishing medium including an oxidizing agent, a protective-film-forming agent, a water-soluble polymer and water. That is, as compared with previously considered claim 1, claim 27 omits recitation of the metal-oxide-dissolving agent.

Of the previously considered claims, claim 1 has been amended to be dependent on claim 27, and to recite that the medium further includes a metal-oxide-dissolving agent; and various of the other previously considered claims, previously dependent on claim 1, have been amended to be dependent on claim 27.

In addition to claim 27, Applicants are adding new claims 28-32 to the application. Claims 28 and 29 expressly set forth subject matter in claims 18 and 19, respectively, but are each dependent on claim 6. Claims 30 and 31, dependent respectively on claims 9 and 18, further define the nitrogen-containing compound, as being selected from the group consisting of ammonia, alkylamines, amino acid, imines, azoles and salts thereof. Note, for example, page 16, lines 8-12, of Applicants' specification. Claim 32, dependent on claim 1, further defines the protective-film-forming agent in light of the specific compounds described at page 18, lines 14-18, of Applicants' specification.

Applicants respectfully submit that all of the claims presently submitted for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed September 22, 2004, that is, the teachings of Levert, et al., United States Patent

Application Publication No. 2001/0054706, and of Kaisaki, et al., No. 6,194,317, under the provisions of 35 USC §103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a polishing medium for chemical-mechanical polishing, or such method of use thereof, as in the present claims, the medium including, in addition to an oxidizing agent and water, both a protective-film-forming agent and a water-soluble polymer. See claim 27.

Furthermore, it is respectfully submitted that these applied references would have neither taught nor would have suggested such polishing medium as referred to previously in connection with claim 27, having features as set forth therein, and wherein the medium additionally includes a metal-oxide-dissolving agent. See claim 1.

Moreover, it is respectfully submitted that the applied references would have neither taught nor would have suggested such polishing medium as in the present claims, having features as discussed previously in connection with claim 27, and, moreover, wherein the water-soluble polymer has a weight-average molecular weight of 500 or more, as in claim 2, more specifically, the weight-average molecular weight as in claims 20 and 21; and/or wherein the polishing medium has a coefficient of kinetic friction of 0.25 or more, as in claims 4 and 13, more particularly, a coefficient of kinetic friction as in claims 22 and 23; and/or wherein the polishing medium has an Ubbelode's viscosity as in claims 5, 14 and 16, more particularly, such viscosity as in claims 24 and 25; and/or wherein the polishing medium has a point-of-inflection pressure as in claims 6, 15 and 17, more particularly, as set forth in claim 26.

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such polishing medium as in the present claims, having features as discussed previously in connection with claim 27 (and/or in connection with claim 1), and having additional features as in the remaining, dependent claims, including (but not limited to) the more specific materials for the oxidizing agent as in claim 7; and/or the more specific materials for the metal-oxide-dissolving agent as in claim 8; and/or the more specific materials for the protective-film-forming agent as in claim 9, particularly as in claims 10 and 30-34; and/or material of the water-soluble polymer as in claims 18, 19, 28 and 29; and/or wherein the medium is used to polish a film which includes at least one of copper, a copper alloy, a copper oxide and a copper alloy oxide (see claim 12).

In addition, even assuming, arguendo, that the teachings of the applied references would have established a prima facie case of obviousness, it is respectfully submitted that the evidence in the specification of the above-identified application, discussed infra, shows unexpectedly better results achieved by the present invention including, inter alia, the protective-film-forming agent and water-soluble polymer, and further establishes unobviousness of the presently claimed invention. Such evidence in Applicants' specification must be considered in determining unobviousness. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984).

In the Office Action mailed September 22, 2004, the Examiner ignored the evidence in Applicants' specification, notwithstanding that Applicants relied on this evidence in their previous Amendment filed June 8, 2004. Note the paragraph bridging pages 10 and 11 of this Amendment filed June 8, 2004. It is respectfully

submitted that the Examiner must consider this evidence, and any failure to consider/provide remarks on this evidence is clearly erroneous. If the Examiner maintains the prior art rejection, it is respectfully submitted that the Examiner must provide comments concerning what she considers to be any deficiencies in the evidence of record.

The present invention is directed to a polishing medium for chemical-mechanical polishing (CMP), and a polishing method making use of this medium, especially suited for polishing in forming wirings of semiconductor devices (for example, in polishing copper and copper-containing materials).

In order to obtain a flat polished surface using CMP, of a surface having hills and dales, with a polishing medium including, inter alia, a protective-film-forming agent, it is important to balance the effect attributable to the protective-film-forming agent used in the polishing medium. It is preferable to use a polishing medium which does not etch a metal film surface oxide layer in the dales, yet which has a high rate of polishing of the hills. In particular, it is preferable that the polishing rate is high, yet wherein the etching rate of the polishing medium is low.

Applicants provide a polishing medium which can form highly reliable buried metal film patterns in a good efficiency keeping a high CMP rate (that is, having a high polishing rate), and wherein the etching rate by the polishing medium is low. Applicants have found that by incorporating a water-soluble polymer in a polishing medium containing, inter alia, an oxidizing agent, a protective-film-forming agent and water, the CMP rate can be made higher, while the etching rate is kept low. See page 7, lines 12-21 of Applicants' specification. Note also the paragraph pages 21 and 22, and page 23, lines 5-20, of Applicants' specification.

Thus, where a polishing medium for CMP which contains 1% by weight of benzotriazole (a protective-film-forming agent) is used, the film is usually polished only a little even when solid abrasive grains are contained in the polishing medium. Moreover, where only a water-soluble polymer is mixed in the polishing medium for CMP and no protective-film-forming agent is included, it is difficult to control etching rate to be low. Through use of the combination of the protective-film-forming agent with the water-soluble polymer, as in the present invention, achievement of both a high CMP rate and a low etching rate is accomplished; and, moreover, through use of this combination of the protective-film-forming agent with the water-soluble polymer, it is not necessary to include solid abrasive grains in the medium.

In addition, as described on pages 8-12 of Applicants' specification, Applicants have found various characteristics of the water-soluble polymer and of the polishing medium as a whole, which enable achievement of much higher CMP rate, higher flattening, lower dishing level and lower erosion level. These characteristics are specific ranges for the weight-average molecular weight of the water-soluble polymer, the coefficient of kinetic friction of the polishing medium, the Ubbelode's viscosity of the polishing medium and the point-of-inflection pressure of the polishing medium. Note especially, page 8, line 23 to page 9, line 2; the paragraph bridging pages 9 and 10; page 11, lines 16-18; and the paragraph bridging pages 11 and 12, of Applicants' specification.

Attention is directed to the Examples and Comparative Examples; and, in particular, the results thereof, as seen in Tables 1-3 on pages 29 and 30 of Applicants' specification. It is respectfully submitted that the Examples and Comparative Examples in these tables constitute evidence in connection with

showing unexpectedly better results achieved by the presently claimed subject matter, and must be considered when determining patentability. See In re DeBlauwe, *supra*.

Thus, in comparing the Examples with Comparative Examples 1-4, unexpectedly better results can be seen in decreased etching rate with improved CMP (chemical-mechanical polishing) rate. Further unexpectedly better results are seen with molecular weight of the water-soluble polymer, point-of-inflection pressure, Ubbelode's viscosity and coefficient of kinetic friction, as in various of the present claims. See page 30, line 3 to page 32, line 12, of Applicants' specification.

Levert, et al. discloses a chemical etching process for the planarization of surfaces, and chemical compositions especially suited thereto, the technique described therein being a spin etch planarization. Note paragraphs [0002], [0019] and [0021] on pages 1 and 2 of Levert, et al. This patent publication contrasts the spin etch planarization to chemical mechanical polishing, as being different techniques, disclosing that chemical-mechanical polishing has several disadvantages which the spin etch planarization described in this patent publication intends to reduce or eliminate. See paragraph [0016] on page 2 of Levert, et al. As for the specific spin etch planarization described in this patent publication, which is disclosed as being particularly suitable for copper and tantalum, note paragraph [0022] bridging pages 2 and 3 of this patent publication. Note also Tables 1-10 in paragraphs [0059]-[0068] on pages 5 and 6 of this patent document, describing various reagent solutions and reagents for planarization of copper and of tantalum.

The Examiner contends that Levert, et al. discloses a composition comprising an etching solution, which includes, inter alia, "an additive such as polyvinyl alcohol

(same as applicants' water-soluble polymer) and carboxymethylcellulose (same as applicants' protective-film-forming agent)". Note the paragraph bridging pages 2 and 3 of the Office Action mailed September 22, 2004.

Applicants respectfully traverse the interpretation by the Examiner of the teachings of Levert, et al., as describing, inter alia, a protective-film-forming agent as in the present claims. Specifically, Applicants respectfully submit that, as described on page 19, lines 7-22 of Applicants' specification (note particularly line 9 thereof), carboxymethyl cellulose is a water-soluble polymer, not a protective-film-forming agent according to the present invention. It is respectfully submitted that Levert, et al. does not disclose, nor would have suggested, a composition including both a water-soluble polymer and protective-film-forming agent as in the present claims, much less advantages achieved through use of both of these materials in combination as discussed previously.

Again, it is emphasized that the present invention achieves high-speed chemical-mechanical polishing while avoiding excessive etching, by using, inter alia, a protective-film-forming agent and water-soluble polymer together. It is respectfully submitted that the teachings of Levert, et al. do not disclose, nor would have suggested, use of such materials together, in a polishing medium as in the present claims, much less the advantages achieved thereby.

It is respectfully submitted that the additional teachings of Kaisaki, et al. would not have rectified the deficiencies of Levert, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Kaisaki, et al. discloses a method of modifying or refining the surface of a wafer suited for semiconductor fabrication. The method includes a first step of

contacting a second material of a wafer to a plurality of three-dimensional abrasive composites fixed to an abrasive article, the three-dimensional abrasive composites including a plurality of abrasive particles fixed and dispersed in a binder. A second step is relatively moving the wafer while the second material is in contact with the plurality of abrasive composites until the exposed surface of the wafer is planar and includes at least one area of exposed first material and one area of exposed second material. This patent further discloses that the second material is typically a metal, and that the first material is typically a dielectric material. See column 2, lines 37-60. Note also column 3, lines 57-65, describing, inter alia, that the second material can be a conductive material which preferably includes metals such as tungsten, copper, aluminum, aluminum copper alloy, gold, silver or various alloys of these metals.

In column 4, lines 20-38 of Kaisaki, et al., in one embodiment, is disclosed a working liquid used with the abrasive article. This patent discloses that one useful working liquid is an aqueous solution that includes a variety of different additives, suitable additives including complexing, oxidizing, or passivating agents, surfactants, wetting agents, buffers, rust inhibitors, lubricants, soaps, or combinations of these additives. This patent discloses that the additives may also include agents which are reactive with the second material, e.g., metal or metal alloy conductors on the wafer surface, such as oxidizing, reducing, passivating, or complexing agents. Examples of oxidizing and complexing agents are also given. Note also column 7, lines 62-67. See also column 12, line 49 to column 15, line 57, providing a further description of the working liquid. One suitable working liquid is disclosed at column 15, lines 38-42, and includes a chelating agent, an oxidizing agent, an ionic buffer, and a passivating agent, these materials, inter alia, being hydrogen peroxide, water,

(NH₄)₂HPO₄ (NH₄)₃ citrate and benzotriazole. Columns 18-22 of Kaisaki, et al. disclose formation of the abrasive article, wherein abrasive particles are dispersed in a binder in the article. Various precursor binders for the binder for binding the abrasive particles to the article are disclosed, which are described as curable organic material.

Initially, it is respectfully submitted that the teachings of Kaisaki, et al. would not have been properly combinable with the teachings of Levert, et al. Thus, Levert, et al. is directed to compositions for spin etch planarization, which this reference characterizes as being different from compositions for chemical-mechanical polishing. In contrast, Kaisaki, et al. discloses chemical-mechanical polishing, particularly a chemical-mechanical polishing using a plurality of three-dimensional abrasive composites fixed to an abrasive article. It is respectfully submitted that one of ordinary skill in the art would not have looked to the teachings of Kaisaki, et al., for modifying the compositions and processes of Levert, et al. In other words, it is respectfully submitted that the teachings of these references are directed to non-analogous arts.

In any event, noting particularly that Levert, et al. discusses deficiencies in chemical-mechanical polishing, it is respectfully submitted that there would have been no motivation for combining the teachings of Levert, et al. and of Kaisaki, et al., as applied by the Examiner.

In any event, even assuming, arguendo, that the teachings of Levert, et al. and of Kaisaki, et al. were properly combinable, such combined teachings would have neither disclosed nor would have suggested the presently claimed composition, including, inter alia, both the protective-film-forming agent and water-

soluble polymer, and advantages achieved thereby. Particularly, in view of the erroneous interpretation of the teachings of Levert, et al. by the Examiner, it is respectfully submitted that the teachings of these references would have neither disclosed nor would have suggested such combination of materials as in the present claims, and advantages thereof.

In addition, it is respectfully submitted that the teachings of these applied references would have neither taught nor would have suggested the other features of the present invention as recited in the present claims, including, e.g., coefficient of kinetic friction, Ubbelode's viscosity, and/or point-of-inflection pressures, of the liquid medium, and advantages thereof. Clearly, a rejection on prior art (under 35 USC §102 or under 35 USC §103) must be based on evidence. See In re McKellin, 188 USPQ 428 (CCPA 1976). Particularly in view of the advantages achieved according to the present invention, having properties as recited in various of the present claims, it is respectfully submitted that the Examiner has clearly not established obviousness of such aspects of the present invention.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR § 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135

(Case No. 566.41259X00) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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A handwritten signature in black ink, appearing to read "William I. Solomon", with a long horizontal flourish extending to the right.

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